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PFAS Preliminary Site Investigation: HMNZS Devonport Naval Base & Satellite Sites

New Zealand Defence Force

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PFAS Preliminary Site Investigation: HMNZS Devonport Naval Base & Satellite Sites

Prepared for

New Zealand Defence Force

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Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by New Zealand Defence Force and others (not directly contracted by PDP for the work), including PAE (New Zealand) Ltd, Babcock (NZ) Ltd, Auckland Council and Wormald New Zealand Limited. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

Owing to the limited nature of this assessment (as described in the Objectives and Scope sections), there could be conditions at the site that have not been identified and which have not been considered in this report. Thus although the assessment has shown knowledge of possible sources of soil contamination, there is a risk that sources of soil contamination could exist which are not identified by the assessment. This risk could be reduced by undertaking further research or subsoil investigation.

This report has been prepared by PDP on the specific instructions of New Zealand Defence Force for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Executive Summary

A preliminary site investigation has been undertaken at the Devonport Naval Base (HMNZS Philomel) (DNB) and Satellite Sites (Torpedo Bay and Narrow Neck), to assess the potential for soil and water contamination resulting from current and historic use of products containing per- and poly-fluoroalkyl substances (PFAS).

PFAS, such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), are a group of over 6,000 human-made organic substances which are gaining increasing scientific and regulatory interest due to their widespread use, their environmental persistence and because some PFAS (primarily PFOS and PFOA) display bioaccumulative and toxic properties to humans and wildlife (CONCAWE, 2016).

Since the 1950s, PFAS have been and continue to be used in a wide range of industrial and commercial products such as textiles and leather products, Teflon, metal plating (e.g. electroplating mist suppressants), paints, the photographic industry, semi-conductors, paper and packing, cleaning products, firefighting foam and aircraft hydraulic fluids. PFAS have been detected globally within the environment, wildlife and humans (Fromme, et al 2009; Environmental Canada, 2012) and are regarded as emerging contaminants because of their perceived potential risk to the environment and human health, and the lack of published environmental and health standards.

The investigation has involved a review of historical aerial photographs, Auckland Council files, information provided by New Zealand Defence Force (NZDF) and their contractors, interviews with site personnel and a site visit. Based on that work, Torpedo Bay and Narrow Neck have been excluded from the study as no PFAS storage or use has occurred at those locations. The main findings are presented below for DNB (the "site"):

- The major source of PFAS at DNB is aqueous film forming foam (AFFF) used for firefighting and firefighting training. The AFFF used and stored on Base is primarily Angus Tridol-S. NZDF has confirmed that Tridol-S does contain PFAS including perfluorooctanoic acid (PFOA) (laboratory analysis (PDP, 2015) indicates Tridol-S does not contain perfluorooctanesulfonic acid (PFOS)).
- The majority of firefighting training using AFFF is undertaken at the Sea Safety Training School (SSTS) located at Ngataringa Bay. Only small amounts have been used at other areas of DNB during firefighting demonstrations.
- Use of AFFF at the SSTS occurs regularly.
- An additional potential source of PFAS at DNB is AFFF stored for firefighting. The AFFF is stored in sealed tanks that are part of the deluge

system associated with the bulk fuel storage tunnels and hazardous goods store, and on every NZDF naval ship.

- Until the mid-2000s, foam blankets were applied to any fuel spill or oil leak on ships, including whilst docked or berthed at DNB or on the water, to prevent a fire establishing.
- There have been no reported incidents involving the activation (either accidental or intentional) of the deluge system in the bulk fuel storage tunnels, or the foam sprinkler system in the hazardous goods store. Furthermore, if some of these products were to contain PFAS it is unlikely to be in significant quantities.
- Based on the current information there is no evidence of other significant sources of PFAS-containing products on site. However, it is acknowledged that although the safety data sheets and manufacturer's websites have been consulted, the exact list of ingredients of the hydraulic fluids, paints and electroplating mist suppressants used on site has not been able to be confirmed.
- As result of this investigation, 21 new areas (mostly PFAS specific) have been added to the NZDF Hazardous Activities and Industries List (HAIL) database.

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1.0 Introduction

Pattle Delamore Partners Ltd (PDP) has been engaged by the New Zealand Defence Force (NZDF) to undertake a preliminary site investigation (PSI) to investigate the potential for soil and groundwater contamination relating to the use of per- and poly-fluoroalkyl substances (PFAS) at the Devonport Naval Base (DNB) and satellite sites (Torpedo Bay and Narrow Neck) in Devonport.

This report provides the detail of the site history information review and a risk assessment in the form of a conceptual site model. The investigation activities and this report have been undertaken in accordance with *'Reporting Templates for Per and poly-fluoroalkyl Substances (PFAS) Investigations on the New Zealand Defence Force Estate'* (PDP, 2016), and in general accordance with the Ministry for the Environment (MfE) '*Contaminated Land Management Guideline No. 1 – Reporting on Contaminated Sites in New Zealand*' (MfE, 2011a), and '*Contaminated Land Management Guideline No. 5 – Site Investigation and Analysis of Soils*' (MfE, 2011b). This report has been prepared under the guidance of, and approved by, a suitably qualified and experienced practitioner (SQEP).

1.1 Objectives

The project objectives for the investigation were as follows:

- Investigate the history of possible PFAS use to identify potential sources of, and approximate areas of, contamination relating to PFAS.
- Develop a conceptual site model to help inform future sampling investigations.
- Update the existing hazardous activities and industries list (HAIL) database with the PFAS specific information identified in the site investigation.

1.2 Scope

The scope of work undertaken to achieve the project objectives was as follows:

- Obtain and review readily available information regarding the historical and current uses. The tasks undertaken included:
  - Reviewing information provided by NZDF: historical plans, photographs, environmental reports, incident database records, stormwater as-builts and records of chemicals used stored and disposed of on site (either historically or currently);
  - Reviewing available historical aerial photographs;

- Reviewing information provided by Auckland Council (AC) as part of a property file;
- Site reconnaissance by PDP environmental consultants;
- Conducting interviews with relevant NZDF personnel and contractors; and
- Preparation of a report detailing the results of the information review and site investigation tasks.

Further details on the tasks carried out as part of this scope of works are provided below.

2.0 Site Description

The Devonport Naval Base and Torpedo Bay and Narrow Neck locations are as follows with legal descriptions stated in Table 1:

- North Yard – offices for teaching and administration and a supply depot including Ngataringa Bay sport fields and the Sea Safety Training Squadron (SSTS), located on Jim Titchener Parade and Ngataringa Bay Access Road, Stanley Point.
- South Yard – the operational part of the Naval Base including the Calliope dry dock, located at the end of Queens Parade, Devonport.
- Calliope Road housing and base associated facilities, Devonport.
- Narrow Neck – satellite site housing personnel accommodation training facilities and engineering and electrical workshops, located at 142 Vauxhall Road, Narrow Neck.
- Torpedo Bay – satellite site housing the Navy Museum, located at 64 King Edward Parade, Devonport.

Table 1: Site Description

Address	Legal Description [1]
Queens Parade, Devonport (includes Calliope Road and North and South Yards)	Lots 43, 44, 45, 46, 47, 48, 49, 50, Part Lot 52 DP 382, Part Lots 1 and 2 DP 25207, SO 33383, Pts Lots 21, 22 and 24 Allot 30 Sec 2 Takapuna Parish. Part Lot 52 DP 382, SO 33383, Part Lots 2 and 3 DP 29302 and Part Lot 3 Allotment 30, Section 2, Parish of Takapuna, closed road, SO 33703, Part Harbour Bed SO 36655, Part Harbour Bed SO 40439, Part Lot 2 DP 83163, and Part Lot 2 DP 29302, SO 56394, Part Auckland Harbour Bed SO 64512 Portion of Lots 53, 54, 55, 56, 57, 58 and 59, DP 1055, SO 22783, Lots 18, 19, Part Lot 59, Lot 60 and 61, DP 1055, SO 25401, Lot 64 and 65, DP 1055, SO 25991, Section 45 SO 25991, Closed road SO 26225, Part Harbour Bed DP 23202, Section 44 SO 22783, Part Allot 32 and 33 of Section 2 and part Harbour Bed, Part Lots 72, 73, 74, 75, 76, Lot 77 DP 1055 SO 28801, Closed Road SO 28803, Part Lot 15 DP 1055, Lots 62, 63, Part Lot 15, 16 and 17, Part Lot 58, Part Lots 56, 57, Part Lot 55, Part Lots 53, 54, DP 1055, and Lot 50 DP 19244, Lots 1, 2, 3, 20, 21, 22, 23, 24, 48, 49 DP 19244, Lot 4 DP 19244, Lots 46 and 47 DP 19244, Part Allot 24A SO 32155, Lots 41 and 42 DP 1055, Part Allot 24A SO 32155, Lots 78, 79, 85 and Part Lot 84 DP 1055, Closed Road SO 32885, Part Waitemata Harbour, Part Allotment 43, Lot 71 DP 1055 SO 33509, Parts Lot 82 DP 1055, Lot 67 DP 1055, Part Lots 74 and 75 DP 1055, Lot 2 DP 21210, Part Lot 66 DP 1055, Lot 1 and 3 DP 21210, Part Waitemata Harbour Bed, Part Lot 66 DP 1055, Lot 1 DP 21210, Lot 3 DP 21210, Part Harbour Bed SO 31401, Part Lot 66 and 68 DP 1055, Parts Lot 68 and 76 DP 1055, Part Lot 90 and 91 DP 1055, Lot 80 DP 1055, Part Lots 91 and 92 DP 1055, Part Allotment 43 and Part Waitemata Harbour, Part Lot 77 DP 1055, Lot 81 DP 1055, Land below Mean High Water Mark, Part Lots 92 and 93 DP 1055, Part Lot 72 DP 1055, Part Lot 73 DP 1055, Part Closed Road, Part Lot 75 DP 1055, Part Allotment 33, Lot 5 DP 1055, Lot 6 and 10 DP 1055, Lot 1 DP 1055, Lot 3 DP 1055, Lot 11 DP 1055, Lot 2 DP 1055, Lot 9 DP 1055, Lot 83 and Part Lot 84 DP 1055, Lot 12 DP 1055, Lot 1 and 2 DP 47545, Lot 51 and 52 DP 1055, Part Bed Waitemata Harbour SO 56784, Part Bed Waitemata Harbour and Part Allotment 32 and 33 SO 61856, Part Lot 92 DP 1055, Lot 1 DP 64521 (CT 20A/1106).
130 Vauxhall Road, Devonport (Narrow Neck)	Sec 1, SO 69845 Terraview: Sec 1 and Sec 2 SO 448861.
64 King Edward Parade, Devonport (Torpedo Bay)	Portion of Allotment 13A and Harbour Endowment, portion of Allotment 13A, Harbour Endowment, part bed of Waitemata Harbour (SO 52566), part bed of Waitemata Harbour (SO59186).

Notes:

1. *Golders Associates (NZ) Limited, 2010; Ramboll Environ New Zealand Limited, 2017; Auckland Council GIS viewer accessed August 2017 (https://geomapspublic.aucklandcouncil.govt.nz/viewer/index.html)*

Combination of these three sites (DNB, Torpedo Bay and Narrow Neck) consists of approximately 38.24 ha of land and these sites are zoned as Business – Mixed Use Zone, Business - Light Industry and Open Space – Sport and Active Recreation Zone and is designated for Defence Purposes under the Auckland Unitary Plan (Operative in Part, 2016).

The surrounding area is predominately residential. Figure 1 shows the location of the site and the key features of the DNB and the satellite sites. Figure 2 shows the HAIL areas identified through this investigation, where PFAS has been used, stored or disposed.

All water used at DNB is supplied from the reticulated system operated by Auckland Council. At the SSTS, reticulated water used for firefighting training is recycled and reused for a period of approximately 4 months before being replaced with fresh water from the reticulated supply. This is further discussed in Section 3.4.3.

2.1 Site Layout

Devonport Naval Base (Figure 2) is a large operating naval base located in Devonport in Auckland's Waitemata Harbour. The North Yard includes a number of offices for training and administration purposes, accommodation, a large supply depot and storage facilities. The South Yard includes the Calliope dry dock, Babcock workshops, wastewater treatment plant, bulk fuel storage facilities and along the eastern side: accommodation, dining facilities and offices. North Yard and South Yard are linked via a tunnel that passes north south through Calliope Point. Most of the DNB is covered with impervious material comprising buildings or sealed areas. The Sea Safety Training Squadron (SSTS), sports complex and playing fields are located at Ngataringa Bay.

The Navy Museum is located at Torpedo Bay; while Narrow Neck is comprised of personnel accommodation, training facilities and engineering and electrical workshops.

2.1.1 Exclusion of Narrow Neck and Torpedo Bay

With the exception of 9 L hand-held fire extinguishers which contain an AFFF water mix, no use or storage of PFAS containing products was identified at Narrow Neck and Torpedo Bay during the course of this investigation and therefore those two locations have been excluded from any further assessment. DNB is considered to be "the site" henceforth.

2.2 Natural Features

2.2.1 Geology and Hydrogeology

The Geological Map of the Auckland Urban Area (Kermode, 1992) indicates that North Yard (including the SSTS) and South Yard are underlain by construction fill

consisting of recompacted clay – to gravel-sized materials which may include demolition debris. The prominent sea cliffs along the northeast boundary of South Yard (within which the bulk fuel storage tunnels are located), are comprised of greenish grey alternating muddy sandstone and mudstone with occasional interbedded lenses of grit (Parnell Grit) of the East Coast Bays Formation of the Waitemata Group. Rocks of the East Coast Bays Formation are expected to make up the bedrock beneath the entire site.

At the SSTS and Ngataringa Bay Sports field, the groundwater flow direction is expected to be in a northeast to northwest direction towards Ngataringa Bay and the harbour. Groundwater flow direction at North Yard is expected to be in a general north direction towards Ngataringa Bay and the Waitemata Harbour. At South Yard, the groundwater flow direction is expected to be in a south to southwest direction towards Stanley Bay and the Waitemata Harbour.

Previous intrusive investigations at the South Yard indicate a layer of construction fill comprising compacted gravel, coarse sand, silt and clay of variable thickness (0.2 – 3.5 m) underlain by Rocks of the East Coast Bays Formation. The groundwater table is 1.4 m to > 4.5 m bgl (PDP, 2009; Golder Associates (NZ) Limited, 2010).

Previous intrusive investigations at the SSTS have shown that a shallow layer of fill comprised of gravelly silty, shelly clay to a depth of at least 1.2 m is underlain by marine silty sand. The groundwater table is 0.5 to 1.0 m below ground level (m bgl) (PDP, 2010; Golder Associates (NZ) Limited, 2016).

At the time of reporting, PDP was not aware of any groundwater monitoring wells in the vicinity of North Yard, however, based on the close proximity of the harbour, groundwater is inferred to be at a depth of 1 m to 1.5 m bgl.

PDP understands that groundwater beneath DNB is not used for potable or non-potable purposes. Groundwater from beneath DNB is inferred to discharge directly to the harbour. Therefore a bore search was not requested from Auckland Council.

2.2.1.1 Sensitivity of the Underlying Aquifer

The sensitivity of the underlying aquifer beneath the site was assessed in accordance with Section 5.2.3 of the MfE (2011c) guidelines:

- The shallow aquifer beneath the site is not artesian;
- The depth to the first water bearing unit is less than 10 m below the potential contaminant source;
- The site is immediately adjacent to an environmental receptor (the Waitemata Harbour).

In accordance with the guidelines the shallow groundwater is considered to be sensitive due to the close proximity to the harbour.

2.2.2 Topography and Hydrology

The central part of Calliope Point, which divides North Yard from South Yard, is comprised of ECBF rocks approximately 25 m above sea level (asl). On the north and south of this high point, vertical cliffs descend to the shore platform. North Yard, South Yard, and the SSTS are constructed on reclaimed land at the base of these cliffs. Ngataringa Bay on the northern side is relatively shallow and there are extensive tidal flats. The majority of the site is flat and there are no streams on site.

2.2.3 Marine Ecology

Ngataringa Bay, which borders the North Yard and SSTS is identified as a Significant Ecological Area Marine 1 and Marine 2 in the Auckland Unitary Plan (Auckland Council, 2017). The Unitary Plan describes the several factors of ecological value in Ngataringa Bay such as the varied habitat including salt marsh and mangrove communities. The intertidal zone is an important wading bird habitat.

The South Yard borders the lower Waitemata Harbour. The marine environment adjacent to the South Yard is extensively modified with wharves and jetties that comprise the Naval Base. Nevertheless, such areas typically support a variety of tolerant marine species.

3.0 Site Information Review

3.1 Historical Aerial Photographs

A review of the historical and current aerial photographs provided by NZDF and photographs by Auckland Council and LINZ were undertaken and are presented below. It is noted that the electronic versions of the photographs were reviewed, allowing for a greater level of detail to be observed than is evident in the printed versions. For North Yard and South Yard, the following aerial photographs were reviewed: 1940, 1950, 1963, 1968, 1977, 1980, 2008 and 2015. The information obtained from review of the aerial photographs was limited and therefore, in consultation with NZDF, no further aerial photographs were obtained or reviewed.

Table 2: Historical Aerial Review

1940 Aerial – North and South Yard (NZDF)

The 1940 aerial is limited to North Yard and South Yard. At the South Yard the dry dock and a number of large buildings are present including the Palmer Building, Blacksmiths and the former plumbing and battery shop. There is a wharf extending south east from the dry dock and another running northwest towards Stanley Bay. Three large tanks, understood to be for bulk fuel storage, are visible to the north west and east of the dry dock.

North Yard has not yet been constructed. There is evidence of some filling of the estuary, however, the majority of North Yard and the SSTS are undeveloped mangroves and tidal flats. The surrounding land use is residential.

1950 Aerial – North and South Yard (NZDF)

At South Yard, additional land has been reclaimed in the northwest of the site and a number of buildings have been constructed including one of the current Babcock workshops (SY86) and the historic Boat Shop (SY100). In the east of the site a large complex of buildings housing administration and barracks have been constructed along the sea wall. The wharf extending in to Stanley Bay has been extended to the northwest.

A significant amount of reclamation has occurred at North Yard and Ngataringa Bay. A number of buildings have been constructed at North Yard including the original Naval Supply Depot (HL_62_DPT), the hazardous goods store (HL_51_DPT), the former vehicle workshops (HL_60_DPT) and the coal storage shed (HL_61_DPT). The SSTS has not been constructed.

The surrounding land use remains relatively unchanged.

1963 Aerial – North and South Yard (NZDF)

At South Yard the western (No. 3) and eastern bulk fuel storage tanks have been removed. Additional buildings including the former paint shop (HL_15_DPT) are visible.

Reclamation has occurred in the western section of Ngataringa Bay. A number of buildings have been constructed at the historical Damage Control School (HL_08_NGA). There is little change in the North Yard.

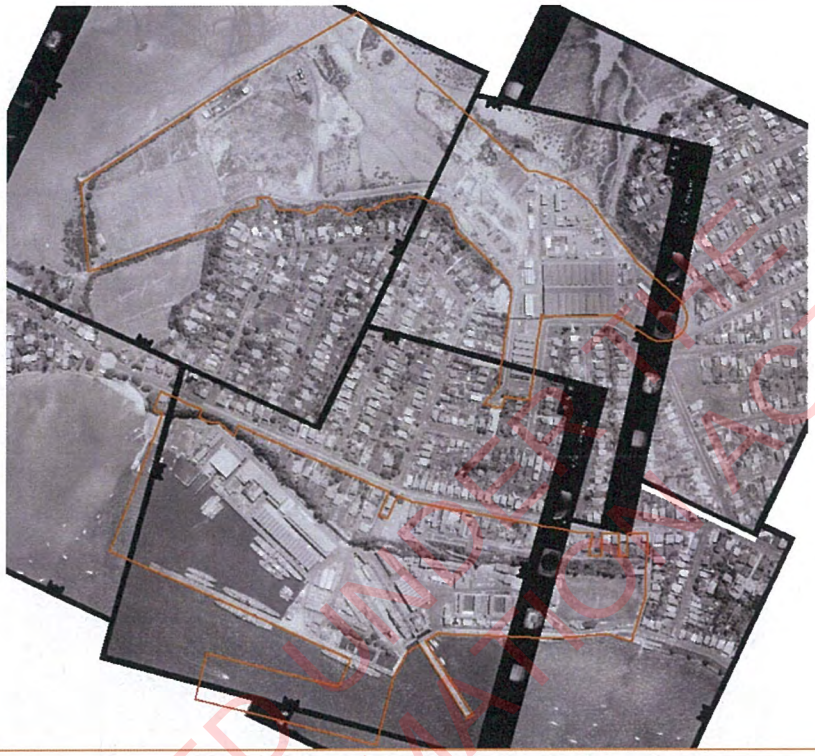
The surrounding land use remains relatively unchanged.

1968 Aerial – North and South Yard (NZDF)

In the 1986 aerial the former E.M. Workshop (HL_41_DPT) had been constructed and the northern bulk fuel storage tank (HL_14_DPT) has been demolished.

The North Yard and Ngataringa Bay have remained unchanged.

The surrounding land use remains relatively unchanged.



1977 Aerial – North and South Yard (NZDF)

In the 1977 aerial further reclamation has occurred at North Yard and Ngataringa Bay. Three buildings have been built in front of the original Naval Supply Depot (HL_62_DPT).

The South Yard and the surrounding land use remain relatively unchanged.

1980 Aerial – North and South Yard (NZDF)

The original Naval Supply Depot has been demolished and upgraded to what it is today.

There is no change at the South Yard between the 1977 and 1980 Aerial.

2008 Aerial – North and South Yard (Auckland Council)

A number of buildings have been constructed at the North Yard and are used for administration, accommodation and training purposes. The Captain Fleet Personnel and Training facility (HL_59_DPT) has been built since the 1980 aerial.

At South Yard, the office buildings (located at the end of Queens Parade) have been constructed. The building in the area which is now used for storage along Cliff Road (HL_12_DPT) has been demolished. The Former Plumbing and Battery Shop (HL_44_DPT) and the Property Maintenance and Laggers Workshop (HL_49_DPT) have been demolished and replaced.

The Calliope Wharf (HL_08_DPT) has been extended to its current position and the former wooden extension (HL_46_DPT) has been demolished.

The former Ministry of Works Workshop (HL_22_DPT) has been demolished.

The SSTS has been upgraded and the site layout is essentially as it is today.

2015-2016 Aerial – North and South Yard (LINZ Data Services)

The 2015-2016 aerial shows North and South Yard essentially as they are today. At South Yard, the former paint shop (HL_15_DPT) and the historic Boat Shop (SY100) have been demolished. The wharf extending southeast from the drydock has not yet been demolished. At North Yard there is little change since the 2008 aerial. The former vehicle workshops (HL_60_DPT) and the coal storage shed (HL_61_DPT) have not yet been demolished.

The SSTS remains unchanged.

3.2 Council Property Files

The Land Information Memorandum (LIM) report was obtained from Auckland Council. The LIM contained information on consents and permits that were approved for the site. The relevant information is summarised below and is appended (Appendix A).

Permit 21071

Resource consent to discharge approximately 12 cubic metres of water onto ground and into the coastal marine area, once every six months, from the Damage Control Training Unit (refer to Section 3.3) was granted in 1998. The consent only covered the discharge of contaminants associated with the testing of the emergency discharge system. It did not cover any emergency discharge from the unit. The consent lapsed in December 2016.

Permit 33593

Resource consent was granted in 2008 to discharge contaminants to air resulting from the operation of combustion plant for heating and the operation of the sea safety training facility. It was conditioned that the fire training fume incinerator chamber would be preheated to 850°C prior to lighting diesel fires in the smoke pans. The consent will expire in 2018.

Permit 33780

A resource consent was granted in 2008 to discharge contaminants to air resulting from abrasive blasting and spray painting for the maintenance of vessels and the operation of the combustion plant for heating and the bulk storage of fuel. The consent will expire in 2018.

Permit 36843

This permit allowed for the discharge of contaminants into water from the washing and water blasting, in excess of 1000psi, of naval and commercial ships alongside the wharves (excluding the dry dock). This consent lapses in 2019.

Building Consent 122313

Building consent was granted to construct a fuel storage facility by installing several tanks in each of the four former underground fuel bunkers. In order to comply with building code, a fire protection system was installed.

Outline Plan of Work OD-2136000 and Building Consent 1245555

To replace the existing wastewater treatment plant tanks with four new tanks and to construct bunding around the proposed tank area. The WWTP intercepts wastewater from the Calliope drydock and synchrolift maintenance area.

RNZN Devonport Naval Base Trade Waste Monitoring: 2007/08 Annual Report for NSCC (Sinclair Knight Merz (SKM), 2008)

SKM were commissioned by NZDF to undertake trade waste monitoring at six locations within the Naval Base (North Yard Pump Station, South Yard Pump Station, Dry Dock WWTP, Narrow Neck, Calliope Road and the SSTS Pump Station). The results from sampling undertaken between April 2007 and March 2008 indicated that the discharges from the tradewaste systems were generally within the acceptable limits of the North Shore City Council (NSCC) consent conditions and the Tradewaste Bylaw. High concentrations of TPH were recorded at SSTS during two sampling rounds. At time of this report, NZDF were in the process of upgrading the wastewater treatment system with the addition of a diesel recovery system.

RNZN Devonport Naval Base Trade Waste Monitoring: 2008/09 Annual Report for NSCC (SKM, 2009)

SKM were commissioned by NZDF to undertake trade waste monitoring at five locations within the Naval Base (North Yard Pump Station, South Yard Pump Station, Narrow Neck, Calliope Road and the SSTS Pump Station). At the time of the report, NZDF held five trade waste consents to discharge trade waste to public sewers. The report concluded that all discharges from the tradewaste systems were within the acceptable limits of the NSCC consent conditions and the Tradewaste Bylaw. PFAS were not included in the trade waste monitoring[1].

3.3 Previous Environmental Investigations

The NZDF provided historical site investigations undertaken within the site. The relevant sections of these reports are summarised below:

Sea Safety Training Squadron Firewater Treatment Plant 2010 Upgrade – Site Investigation (PDP, 2010)

PDP were commissioned to undertake a soil investigation for the new bund at the FTU Fire Treatment Plant. The proposed area was thought to be impacted by petroleum (diesel and associated contaminants). Soil sampling concluded that all concentrations of petroleum hydrocarbon residues found in the samples were within the Auckland Regional Council Permitted Activity Criteria.

[1] PDP undertook trade waste testing at DNB from 2009 to 2016, during which time PFAS was not included in the trade waste analysis suite. It is understood Watercare are now undertaking trade waste testing for DNB.

South Yard Devonport Naval Base – Phase I Site History Assessment (Golders Associates, 2010)

A comprehensive site historical investigation of the South Yard was undertaken by Golders to identify historic and current land use activities that may have resulted in soil and/or groundwater contamination.

Historic site plans identified the presence of underground services including oil lines and fire suppressant transfer lines. The 1935 plan shows a network of pipes for supply of the fire suppressant 'Foamite'; connecting two tanks (identified as HL_31_DPT in the Ramboll HAIL Report) to a building identified as the 'Foamite' pump room (note 'Foamite' was a foam based on sodium bicarbonate (bicarbonate of soda – used in cooking), PFAS based foams were not developed until the 1960s).

Records from a site visit in 1983 documented liquid waste sources and noted that the Battery Shop (Electroplating, SY84 (HL_44_DPT) was discharging dilute cyanide rinsings. SY84 was built in the 1940s and had been demolished in 2005.

South Yard – Phase II Soil and Groundwater Contamination Assessment (Golders Associates, 2012)

Golders were engaged by NZDF to assess whether soil and groundwater conditions triggered the requirement for a long-term discharge permit. The investigation was to assess the nature and extent of soil and groundwater contamination across the South Yard associated with historical reclamation and land use activities. 54 boreholes and 15 groundwater monitoring wells were installed and collection of soil samples was undertaken. There was evidence of contaminants entering the soil and groundwater (for example: metals/metalloids, PAH and hydrocarbons including Light Non-Aqueous Phase Liquid), however, it was concluded that the contamination detected was not considered a high level of risk to occupants or the environment. PFAS were not tested for in this assessment.

NZDF SSTS – Detailed Site Investigation (Golders Associates, 2016)

Golders were commissioned by NZDF to undertake a detailed site investigation of the SSTS facility in Ngataringa Bay. The facility includes a Fire Training Unit, a Fire Bay and a workshop garage (which is for the storage of firefighting training equipment). Five groundwater monitoring wells at SSTS were installed. Groundwater and soil samples were collected and analysed for PFCs (per-fluorinated compounds, more recently referred to as PFAS) (Appendix B):

- Trace concentrations of PFAS were detected in two soil samples but were below the adopted tier one criteria for an industrial use[2];
- PFAS compounds were detected in samples collected from 4 groundwater monitoring wells. The concentration of perfluorooctanesulfonic acid (PFOS) detected at three of those wells exceeded the adopted screening criteria[3];
- PFOS exceeded criteria for the protection of aquatic organisms in monitoring well MW5; and
- PFOS was detected in all intertidal zone soil samples except the shallow control sample. Concentrations of PFOS were below the adopted screening criteria for protection of human health. Higher concentrations were observed in shallow soils closest to the SSTS. Golders' suggested that an off-site discharge of these contaminants had occurred, or was occurring.

Ngataringa Bay – SSTS Tank Containment Review (BECA, 2016)

Beca reviewed the current state of hazardous substance compliance for the Damage Control Training Unit (DCTU) and Fire Training Unit (FTU) at the SSTS located at Ngataringa Bay:

- The DCTU simulates a hull breach by flooding a room with water supplied from the DCTU water tank. Once the simulation is finished, the water returns to the tank and is dosed with chlorine. The contents were not considered a hazardous substance and no controls or requirements for secondary containment were recommended;
- At the FTU, fires are fought using water from a FTU clean water tank in combination with foams. Run-off (including stormwater runoff) is collected in a sump and pumped into a dirty water tank, which is passed through a SEPA oil separator and returned to a clean water tank; and
- It was uncertain whether a cut-off drain was constructed as conditioned by Permit 40949. It was recommended that if one had not been constructed; an alteration to the permit was required and secondary containment should be considered.

[2] Government of Western Australia Department of Environment Regulation (2016) '*Interim Guideline on the Assessment and Management of PFAS*' – human health (industrial).

[3] Government of Western Australia Department of Environment Regulation (2016) '*Interim Guideline on the Assessment and Management of PFAS*' – ecological criteria 80% species protection.

Sea Safety Training Squadron – Groundwater Monitoring (Tonkin & Taylor Ltd, 2017)

Tonkin & Taylor were commissioned to carry out two rounds of groundwater monitoring. Monitoring was carried out in October 2016 and April 2017. The sample results were compared to the Australian Government Department of Health (DOH) PFAS guidelines and CRC CARE (Australia) ecological guidelines for the protection of 80% of marine species[4]. Results were:

- The concentration of PFOS/PFHxS in all five wells exceeded the Australian DOH human health guidelines for recreational water quality;
- Two wells (MW1 and MW2) downgradient of the seawall were reported to contain PFOS at 45 times and 80 times the DOH water guideline respectively;
- A very high concentration of PFOS reported during the October 2016 monitoring round was not repeated in the April 2017 monitoring round. T&T concluded that cross-contamination may have occurred during sampling in October 2016;
- All PFOS concentrations were below the CRC CARE ecological guidelines;
- PFOA concentrations were below the human health and ecological guidelines applied by T&T; and
- T&T concluded that PFAS concentrations appear to be "fairly steady" across the site. These results have been tabulated in Appendix B.

NZDF HAIL Investigation Report for Devonport Naval Base & Satellite Sites (Ramboll Environ New Zealand Limited, 2017)

The report identifies six HAIL activities specifically related to fire training and AFFF storage and use. Ngataringa Bay has been used for firefighting training since the 1960s. The SSTS is currently operating in the same area and has been listed as high priority. Five HAIL activities have been identified in the report relating to electroplating and associated electrical works including the New Dive School Area which historically was a battery shop; these are listed as low to high priority. Four activities have been identified as potential sources of AFFF and PFAS; including Calliope Graving Dock which was a large dock used for maintenance of large vessels and for storage of large quantities of chemicals. These activities have been listed as medium to high priority. Lastly a former 'foamite storage and pump room' has been identified as a potential historical source (1935 to circa 1960s). NZDF have identified two sites as potential HAIL

[4] The CRC CARE guidelines were applied by Tonkin & Taylor, however, these are not considered to be acceptable due to factors relating to the way in which they were developed. The CRC CARE guidelines are not used in the current investigation undertaken by PDP.

activities which are not part of the HAIL assessment undertaken by Ramboll Environ – former bulk fuel storage area or the former engineering workshop.

Industrial or Trade Activities – Environment Management Plan Devonport Naval Base (NZDF, 2016)

All wastewater generated from training activities at the SSTS discharges to a trade waste sewer via the on-site wastewater pre-treatment plant (WWTP). The WWTP separates the diesel and water, which are reused in fire training activities. There are two catchpits near the SSTS office building which discharge to the stormwater system. The area is bunded and any activity with the potential to discharge contaminants is undertaken in areas that drain to trade waste. Spill kits are kept at the facility and in the event of a large spill, the firefighting foam spill response plan is implemented.

Ngataringa Bay Trade Waste Management Plan (Environmental Services, 2016)

The separator is inspected monthly, solids are cleaned out every 6 months and the tanks are inspected and cleaned annually.

Trade waste is discharged via the wastewater networks to the public network at Ngataringa Bay Access Road.

In an event of a power failure, the training facilities are not operational.

During flood events (heavy rain and a king tide) the SSTS site and surrounding area is under water and there is high risk of sea water entering the wastewater system – it was stated that no preventative measures can be taken.

3.4 Information Provided by New Zealand Defence Force

3.4.1 Staff and Contractor Interviews

Prior to the site visit by PDP staff, a series of questionnaires were provided to key personnel from the SSTS, Base Operations, Facilities Maintenance, Naval Supply Depot and contractors who may have, or currently do use, store or dispose of PFAS containing products.

Collection of the completed questionnaires and additional interviews were undertaken by PDP staff during the site visit on 27 and 28 July 2017. The people interviewed for this report are listed in Table 3.

Table 3: NZDF Personnel and Contractors Interviewed

Name	Position	Unit / Company
s. 9(2)(a)	Fleet Engineering Authority	Marine Superintendent Platform Systems
	Head of School (Trade)	Fleet Personnel & Training Organisation
	Utility Officer North	Defence Estate and Infrastructure Northern
	Storeman	Naval Supply Depot
	Nav OSH	Nav OSH
	Base Facilities Officer	Base HQ
	Environmental Officer	Environmental Services
	Babcock Quality Assurance and Environmental Manager	Babcock International Group
	Manager	SSTS
	Oil Fuel Officer	Babcock International Group
	Engineer	Babcock International Group
	Industrial Coatings	Babcock International Group
	FM Site Supervisor	Defence Estate and Infrastructure Northern

A summary of the key findings from the interviews, site walkover and information provided by NZDF and contractors, is provided below. The completed questionnaires and transcripts of the interviews conducted on-site are provided in Appendix C. The responses to the questionnaires were completed by each individual; additions made by PDP personnel during on-site interviews are clearly identified. Site photographs are provided in Appendix D.

3.4.2 Identification of HAIL Sites

Each PFAS specific HAIL site identified through this PSI or prior investigations has been given a unique code in accordance with the *NZDF HAIL Investigation Report & GIS Specifications* (PDP, 2016), e.g. HL_03_NGA Seamanship Safety Training Squadron – Current Operations, these are shown on Figure 2.

3.4.3 Firefighting Training at SSTS

The main use of PFAS containing products at DNB is AFFF which is used for firefighting training and firefighting. Information supplied by NZDF indicates that there are five AFFF products stored and used at Devonport Naval Base including: 6% Angus Tridol-S; 3% Angus Tridol-S; 3% Foam Tec; 6% Foam Tec and 3% Ansulite.

Firefighting training is undertaken at the SSTS and includes training with both fire hoses and hand-held extinguishers. With the exception of a demonstration once a month using the FB5X foam nozzle (during which approximately 5 L of AFFF is discharged), hose training only uses recycled water which has passed through the SEPA unit and a UV treatment. This is further discussed below. Fire extinguisher training is undertaken using 9 L hand-held extinguishers containing AFFF, carbon dioxide and dry powder. These extinguishers contain 6% Angus Tridol-S which is diluted 1 part AFFF to 99 parts water during the use of the extinguisher. This equates to the release of 600 mL of AFFF (6% Tridol-S) per 9 L extinguisher. The AFFF typically used for training is expired AFFF that has been removed from the on-board ship systems. Information provided by s. 9(2)(a) (Manager SSTS), indicates training using this configuration has been occurring since at least 2000 (Appendix C).

s. 9(2)(a) estimated that weekly use of AFFF for firefighting training is approximately 2-3 hours a week. Training classes are up to a maximum of 16 personnel and each trainee would discharge an entire 9 L extinguisher. s. 9(2)(a) estimated the total annual volume of AFFF used at the SSTS is 1,000 L.

Fire training at the Fire Training Unit using hand held extinguishers containing AFFF occurs inside the purpose built FTU, on the helicopter fire pit (located outside on an upper level of the FTU) and on the outside fire pits located adjacent to the FTU. Typically, this involves the lighting of an accelerant such as diesel or gas, which is then extinguished.

The outside fire pits have a concrete block wall on three sides designed to prevent overspray. However, in some cases it is understood minor amounts of overspray near to or into the harbour have occurred. The entire area where training is undertaken is paved. Within the SSTS compound, all catchpits (including stormwater) drain to the SEPA oil water separator. This is with the exception of one catchpit located adjacent to the entrance to the administration block. The ground surface is sloped so as to prevent water from the training area entering this catchpit.

As wastewater passes through the SEPA unit some of the diesel is removed. The water is then passed through an ultra violet light and stored in large tanks ready for reuse in fire training. Every four months the entire system is cleaned

including the FTU and the water recycling system. Water in the tanks is emptied in to the trade waste system and the tanks are cleaned by PAE. Sediment in the tanks is removed and taken off-site by Salters or Intergroup. Due to the physiochemical properties of PFAS, it is unlikely that they are completely removed via the aforementioned treatment process. Consequently, water discharged to trade waste and sediment removed from the tanks will most likely contain PFAS.

The agitation of AFFF passing through the SEPA unit often results in the formation of foam which bubbles out of the system and collects on the paved surface below (see Photo 10 in Appendix D). s. 9(2)(a) reported that on windy days the foam has been observed to be blown on to the unpaved ground adjacent to the SEPA unit. And during strong winds foam has blown through the boundary fence towards the sea.

During certain conditions (king tides, high rainfall and a strong northerly wind) the SSTS will flood. In some cases, over 30 cm of water has covered the entire SSTS. As flood water recedes, residual AFFF and diesel on the paved surface of the SSTS may be discharged in to the harbour and stormwater catchpits that are not connected to the SEPA unit.

Equipment and clothing worn during firefighting training is initially cleaned on the concrete pad beneath the FTU. Firefighting clothing is also washed in industrial washers located on the ground floor of the SSTS administration block and all waste water generated is directed to trade waste.

The current SSTS complex, including the SEPA unit, was constructed in 1993. Prior to this date, it is understood the majority of the site was covered in gravel and that fluids used during training, such as AFFF and diesel, would have soaked into the ground.

3.4.4 Deluge Systems and Hand Held Extinguishers

There is an AFFF deluge system installed in the bulk fuel storage tunnels (HL_65_DPT). This was commissioned in 2009. The AFFF (Ansulite 3% AFC-3A) is stored in two stainless steel 1,000 L tanks, each within secondary containment and located at the tunnel portal. No foam is stored within the system (i.e. within the pipework in the tunnels) and the system remains empty until an incident. Activation of the AFFF system requires the use of a boost pump fitted to NZ Fire Service Emergency Vehicle. Once activated, foam is contained within the bulk fuel storage bunding. There are no drains within the bunding so expelled fluid must be removed and disposed of using externally contracted vacuum trucks. It is understood the contract for this work is currently held by Salters. There have been no recorded activations or spills associated with this deluge system.

There is an automatic AFFF deluge system installed in the Hazardous Storage Unit (HSU) (HL_51_DPT). The AFFF storage tank, containing 1,136 L of Ansulite 3%, is

located alongside the northwest exterior wall of the Hazardous Goods Store and is contained within a concrete bund. The original foam enhanced deluge system was commissioned in 1995 after it was determined that the sprinkler system alone would not extinguish a fire. The system was upgraded by Wormald in 2010. There are no recorded activations of this deluge system, either for testing or in a real event. Additional information regarding the deluge system is provided in Appendix E.

At numerous locations across the site there are 9 L hand-held fire extinguishers which, when mixed at the correct concentration, contain approximately 600 mL of AFFF. It is understood these are maintained by Argus at a location off-site.

All RNZN vessels have AFFF on board in multiple configurations including bulk storage for ship deluge systems, portable containers of ~20 L which can be connected to the on-board fire hose system, and 9 L hand-held extinguishers.

There is anecdotal evidence that on at least two occasions there have been accidental activations of a ship deluge system while the ship was alongside the dock. In one instance the activation was reported to have occurred while the ship was in the cry dock (pers comm. s. 9(2)(a) Appendix C). It is understood approximately 1,500 L of water/AFFF mix was washed in to the dry dock and directed to the dry dock waste water treatment plant (HL_18_DPT). It is estimated this occurred between 2009 and 2011; however, the exact date of this event is currently unknown. The dry dock wastewater treatment plant is further described in Section 3.4.8.

3.4.5 Bulk Storage and Transport of AFFF

Aside from storage of AFFF in the deluge systems as described in Section 3.4.4, bulk stores of AFFF are also held at:

- The HSU at North Yard. AFFF is stored in the containers as received from the supplier, primarily this is in 205 L drums and 20 L drums. At the time of the site walkover there was one pallet of 20 L drums and two pallets of 205 L drums. s. 9(2)(a) who operates the hazardous goods store stated that replacement AFFF (i.e. for ship deluge systems) is ordered when required and therefore only one or two pallets of AFFF are typically stored at any one time (see Appendix C). The HSU is constructed with secondary containment.
- The SSTS. AFFF used for fire training is stored in a plastic 1,000 L International Bulk Carrier (IBC) located on a spill pallet beneath the Fire Training Unit (FTU). The area is concreted and drains to the interceptor which directs all fluids to the SEPA unit.

Information received from NZDF indicates a total of at least 1,160 L of Tridol-S AFFF is stored on site; approximately 2,000 L of Ansulite AFFF is stored in the deluge systems associated with the bulk fuel storage (the deluge systems are

described in more detail in Section 3.4.4 below); approximately 8,000 L of Tridol-S is carried on the ships. Additional information on the firefighting foam used at Devonport Naval Base is provided in Appendix F.

Information supplied by s. 9(2)(a) from Chubb New Zealand (Appendix G) states that Chubb, who supply NZDF with AFFF, are transitioning to Ansulite AFC-3MS foam. While this formulation still contains PFAS, these are shorter carbon chain (C6) molecules and, therefore, do not contain PFOS and PFOA. It should be noted, however, that many of these shorter chain compounds have the potential to bioaccumulate. The Ansulite AFC-5A foam is not a C6 formulation foam.

Historically, protein based firefighting foam has been stored and used on-site. It is currently unknown what brand of protein foam was used and hence whether or not the foam contained PFAS.

Expired AFFF destined for disposal is stored at the HSU. The majority of expired AFFF is sent to the SSTS for use in firefighting training. Any AFFF not required by the SSTS is disposed of off-site by Salters.

Transport of AFFF around the base is undertaken using trucks and fork hoists. When AFFF is transferred from the HSU to the ships, it remains sealed in the containers as received from the supplier. The 20 L drums are loaded straight on-board. AFFF is pumped from the 205 L drums in to the storage tanks of the deluge systems. Replacement of AFFF on the ships occurs every 3 years. According to s. 9(2)(a) small spills (1-2 L) of AFFF have occurred, and would probably have been washed in to the harbour during clean-up.

There is an Emergency Response Truck (ERT) on site that historically contained approximately 20 L of AFFF stored in two. 9 L hand held extinguishers. According to the ERT vehicle commander, s. 9(2)(a) these extinguishers have been removed and replaced with dry powder extinguishers. The AFFF extinguishers have been returned to the NSD. When not in use, the ERT is parked at the Command Centre, South Yard. According to Naval Occupational Safety and Health (NAVOSH) records provided by s. 9(2)(a) there have not been any incidents involving the use of AFFF from this vehicle.

3.4.6 Foam Blankets for Fire Prevention

Foam blankets are applied to fuel spills to prevent a fire establishing. According to s. 9(2)(a) it was standard operating procedure to lay a foam blanket (using AFFF) on any fuel spill or oil leak on ships, including whilst docked or berthed at DNB or on the water (HL_64_DPT). This procedure ceased in the mid-2000s approximately, however still remains an SOP for spills internally on the ship. It is currently unknown if this procedure was used for spills on other parts of the base.

3.4.7 Firefighting Demonstrations

Historically, demonstrations of firefighting were conducted at the Leadership Development Group Parade Ground (HL_75_DPT). Information provided by DNB personnel stated that demonstrations would involve placing a steel tray on the paved ground surface which would contain wood and diesel (Appendix C). This would be set alight and then extinguished using one or two 9 L hand-held extinguishers. It is estimated demonstrations occurred approximately 3 times a year between 2004 and 2012; however, the exact dates have not been confirmed.

Similar firefighting demonstrations, made during naval oper days, were held at the Philomel Parade Ground (HL_84_DPT). Information provided by s. 9(2)(a) indicates this only occurred on one or two occasions and the location where this occurred is within the area currently being remediated. The current remediation has involved excavation and removal off-site to landfill of material to a depth of 0.5 m, import of cleanfill and re-surfacing.

3.4.8 Hydraulic Fluids, Vessel Maintenance and Electroplating

Currently it is unknown if any hydraulic fluids used at DNB contain PFAS due to the large variety of products used. However, all waste oils and fluids generated during the maintenance of machinery and equipment is stored in a 1000 L tank (contained with secondary containment) within the Babcock engineering building (HL_66_DPT). When the tank is full, Salters remove the waste oil off-site. Depending on the work being undertaken it can take between one week and 3 months to fill the tank.

As detailed in the NZBR 149 Volumes 1 and 2, RNZN Ship Husbandry, and Surface Coatings Manual, there is large variety of surface coatings, paints and sealants used for marine applications at DNB, and a detailed investigation of the ingredients of each product is beyond the scope of this report. The majority of paints and coatings used are understood to be epoxy based coatings and antifouling paints manufactured by International Paint (a business unit of Marine & Protective Coatings, AkzoNobel). As an indication, a selection of the product safety data sheets were reviewed, and no products containing PFAS were identified. International Paints do manufacture a product called Intersleek 900 which is described as a fluoropolymer antifouling paint, however, based on information provided by NZDF and Babcock, this product is not used on Navy vessels at DNB. Paints are stored within secondary containment in a number of locations around the dry dock and Babcock facilities (HL_68_DPT; HL_72_DPT; HL_74_DPT). Information supplied by s. 9(2)(a) (Appendix C) indicates that up to 4 tonnes of paint may be required to re-paint a ship, and typically there is a ship in the dry dock undergoing repainting every 3 weeks. Most paint is applied using a spray unit. Painting equipment is generally cleaned within the dry dock, or occasionally at the paint shop (HL_71_DPT).

All waste fluids from the dry dock are pumped through the wastewater treatment plant (WWTP) (HL_18_DPT). Sediment collected in the WWTP is transferred to 200 L steel drums which are sealed and stored adjacent to the WWTP prior to removal and disposal off-site by Intergroup. Treated water is discharged to the Council sewer. Due to the physiochemical properties of PFAS, it is unlikely that they are completely removed via the treatment process. Consequently, water and sediment discharged and removed from the WWTP will most likely contain PFAS.

Waste coatings, paint, solvents and paint tins are currently stored within re-purposed plastic IBCs located on the paved area adjacent to the wastewater treatment plant (HL_12_DPT). Anecdotal evidence indicates this area has been subject to spills (Appendix C) and evidence of spilling on the sealed area was noted during the site walkover.

It is understood that electroplating historically occurred at the former electrical workshop (battery shop – electroplating, HL_44_DPT) at South Yard (Building SY84) and was operative from the 1940s to 2005 (Ramboll Environ New Zealand, 2017; pers. com s. 9(2)(a) Appendix C).

Mist suppressants are commonly used during chromium plating as it reduces airborne exposure to chromic acid. Surfactant-based suppressants contain PFOS and have been in use since the 1950s. Currently it is unknown what mist suppressant(s) was used for electroplating at DNB.

4.0 HAIL Assessment

In accordance with NZDF procedures, the NZDF HAIL database has been updated with the additional PFAS HAIL sites identified during this PSI. A total of 21 new HAIL sites relating to PFAS have been added to the database, in addition, several existing HAIL sites have been updated with information gathered during this investigation. The relevant HAIL categories are:

A2: Chemical manufacture, formulation or bulk storage;

I: Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment.

A number of unconfirmed potential sources of PFAS have been identified associated with the use of photographic fluid, paints, hydraulic fluids and electroplating mist suppressants. No information has been provided that indicates any of the above substances used at DNB either historically or currently contained PFAS, but neither has it been ruled out. For the purposes of this PSI it is considered that the information reviewed has not shown that it is more likely than not that PFAS has been used, stored or disposed of in association with the above substances. Consequently, the use, storage and disposal of photographic

fluid, hydraulic fluids, paint and electroplating mist suppressants is not considered further in this report.

The location of these sites is shown on Figure 2.

5.0 Risk Assessment

5.1 Conceptual Site Model

A risk to human health can only exist if there is a hazard (i.e. a source, for example contaminated soil, dust or water), a receptor (i.e. people) and an exposure pathway linking the hazard and the receptor. An absence of any one of these components means no risk can exist. A conceptual site model (CSM) is designed to identify the hazards, receptors and possible links between these.

A hazard or source may exist in the form of contaminated concrete, soil, sediment, stormwater, waste water, surface water or groundwater resulting from the storage and / or use of PFAS containing products (i.e. AFFF).

Sources of PFAS that have been identified include:

- Fire training at the SSTS;
- Storage of AFFF at the SSTS, HSU, and in the deluge/fire suppressant systems; and
- The wastewater pre-treatment system at the SSTS.

Potential sources of PFAS that have been identified include:

- Possible storage of AFFF in other locations around the site both historically and currently;
- Transport of AFFF around DNB;
- Fire prevention blankets on ships when in the dock or berthed; and
- Wastewater pre-treatment system at the Calliope Graving Dock.

The potentially complete exposure pathways that have been identified include:

- Direct contact by human and ecological receptors, either with soil, sediment (including marine sediment), stormwater, trade waste, groundwater or sea water;
- Runoff from contaminated concrete or soil in to stormwater on-site;
- Infiltration in to groundwater;
- Wind and spray drift;
- Discharge of groundwater off-site to marine receptors in the Waitemata Harbour (Ngataringa Bay and Stanley Bay);

- Discharge of stormwater off-site to marine receptors in the Waitemata Harbour (Ngataringa Bay and Stanley Bay); and
- Discharge of trade waste off-site to municipal sewerage network.

The receptors of concern include:

- Workers using AFFF containing PFAS (e.g. contractors refilling deluge systems, SSTS personnel filling fire extinguishers and training with AFFF).
- Workers undertaking maintenance and cleaning of the wastewater system at the SSTS, and potentially the dry dock, via dermal contact or ingestion of trade waste or sediment/sludge.
- Workers who are undertaking any future maintenance or excavation activities via:
  - dermal contact and /or ingestion or inhalation of soils;
  - dermal contact or ingestion of stormwater, trade waste, groundwater or sediment.
- Off-site users of the marine environment via exposure to sediment or sea water (e.g. for recreational purposes); and
- Consumers of fish and/or shellfish from the marine environment.
- Potential environmental receptors include groundwater, the Waitemata Harbour and the plants and animals living within these environments.

The pathways are also summarised in the attached CSM (Figure 3, 4 and 5). Figure 3 shows a plan view of the site and surrounding area, and identifies the location and spatial relationship of sources, pathways and receptors (note, due to the plan layout of Figure 3, only some of the sources, pathways and receptors presented in Figures 4 and 5 are able to be displayed).

Figure 4 provides the CSM laid out in a flow chart that identifies sources, pathways and potential receptors. Note that in accordance with PDP (2016) direct exposure of Base personnel to AFFF products is not assessed in the CSM because NZDF will address this exposure as part of its responsibilities under the Health and Safety at Work Act, 2015.

The Devonport PSI Conceptual Site Model – Profile (Figure 5) provides a pictorial cross section of the site and surrounding area, and provides further information on sources, pathways and receptors, particularly subsurface.

5.1.1 CSM Limitations

The information used to inform the CSM has been based on interviews with NZDF personnel and contractors. Some of this anecdotal information has not been confirmed by other means. At present, there is no evidence that other significant sources of PFAS exist on the site.

6.0 Summary and Conclusions

A preliminary site investigation has been undertaken at HMNZS Devonport Naval Base, to assess the potential for soil, groundwater and marine contamination resulting from current and historical use of PFAS. No sources of PFAS were identified at Torpedo Bay or Narrow Neck and these locations have not been considered further.

The main sources of PFAS at DNB are concluded to be:

- Hot fire training in which accelerant or a gas is set alight before being extinguished with foam. Currently undertaken using 6% Tridol-S mixed at a concentration of 1% at the SSTS (HL_03_NGA). It is understood that fire training as described above has only occurred at the SSTS.
- Foam blankets applied to fuel spills. It was standard operating procedure to lay a foam blanket (using AFFF) on any fuel spill. This included fuel spills that occurred on ships and on the water.
- AFFF deluge systems. However, there is no evidence that these systems have ever been activated.
- Storage, transport and handling of AFFF at various locations around the Base.

Based on the current information there is no evidence of other significant sources of PFAS containing products on-site.

As result of this investigation, 21 new areas potentially affected by PFAS have been added to the NZDF HAIL database.

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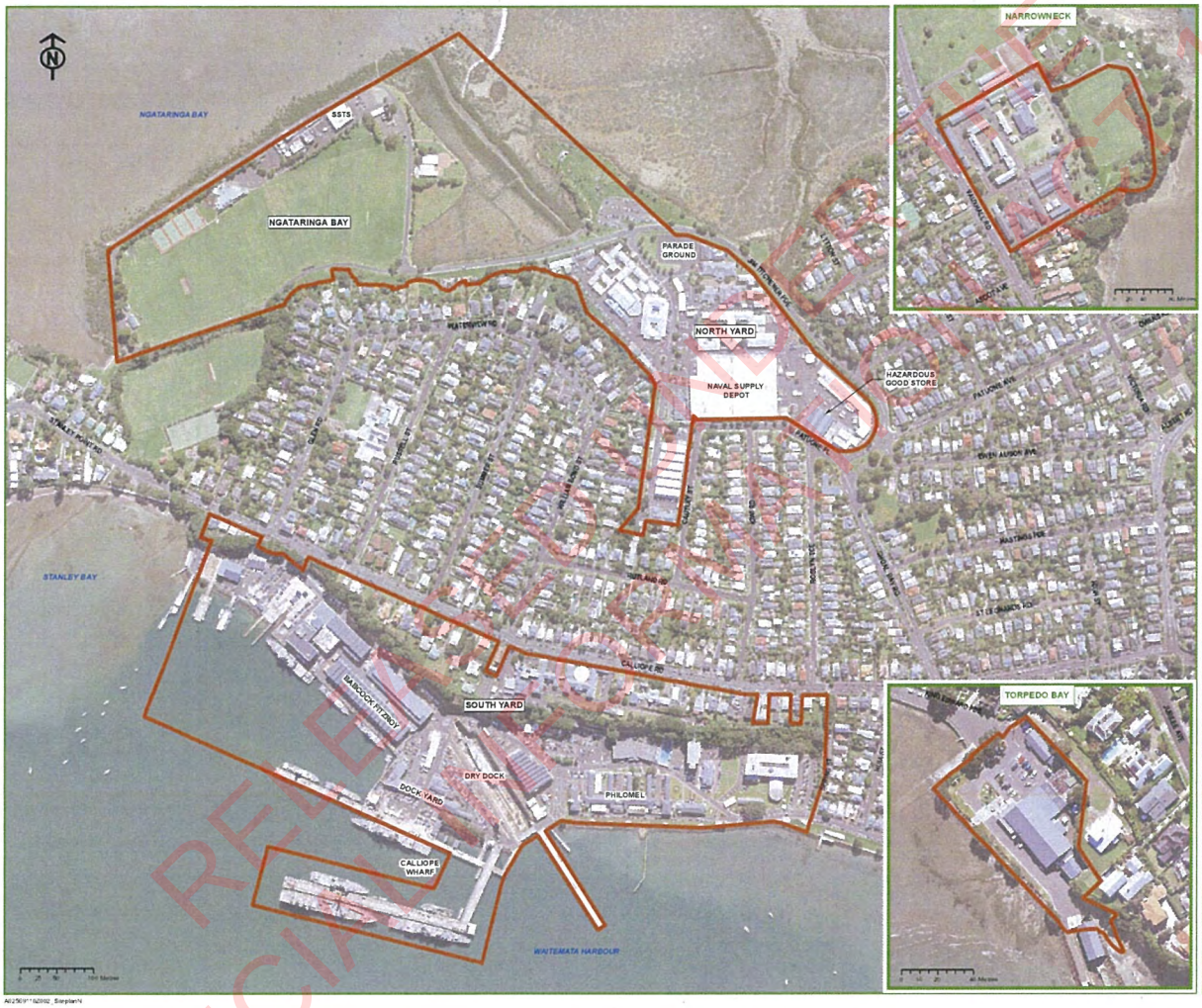

New Zealand DEFENCE FORCE
Te Ope Kātua O Aotearoa
NAVY | NZ ARMY | AIR FORCE

KEY :

Base / Camp Boundary

SOURCE:
Aerial imagery Town 2015-2016 supplied Auckland Council
Topographic information supplied by LINZ
Cadastral information supplied by NZCP dated 19/10/16.

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NO.	REVISION/ISSUE	DATE

pdp

PROJECT NAME:

HMNZS DEVONPORT NAVAL BASE
PFAS PRELIMINARY SITE INVESTIGATION

FIGURE TITLE:

SITE LAYOUT PLAN

SCALE:		FIGURE NO.:	ISSUE NO.:
1:5,000	(A3)	1	B

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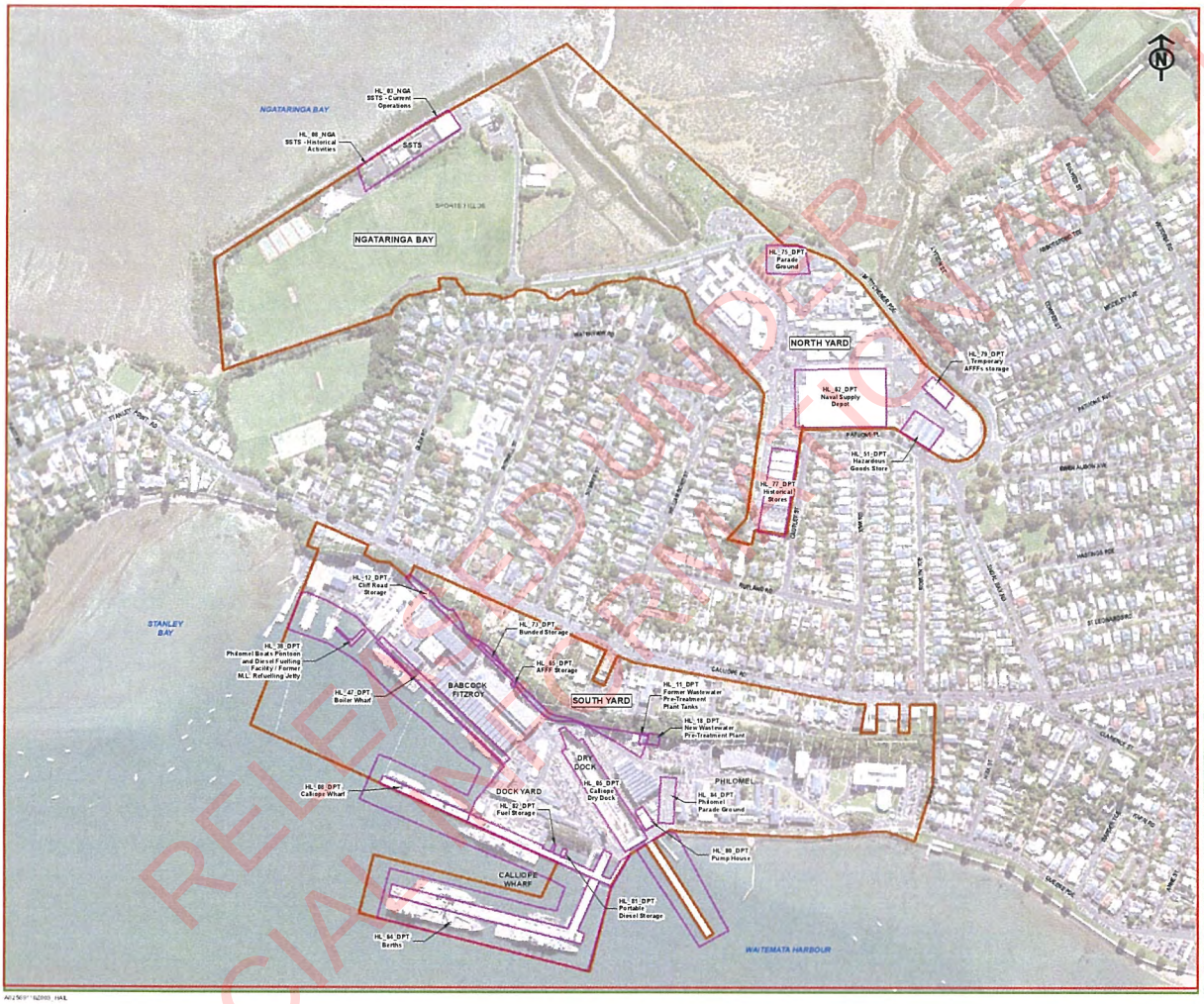

New Zealand DEFENCE FORCE
Te Ope Kātua O Aotearoa
NAVY NZ ARMY AIR FORCE

KEY :

Potential PFAS Source (and Site ID)

Base/Camp Boundary

SOURCE:
Aerial imagery flown 2015 20th. contours, overland flow path and catchments supplied by Auckland Council. Vertical datum of contours Auckland 1946
Topographic information supplied by LINZ
Cadastral information supplied by NZLR dated 19/10/16

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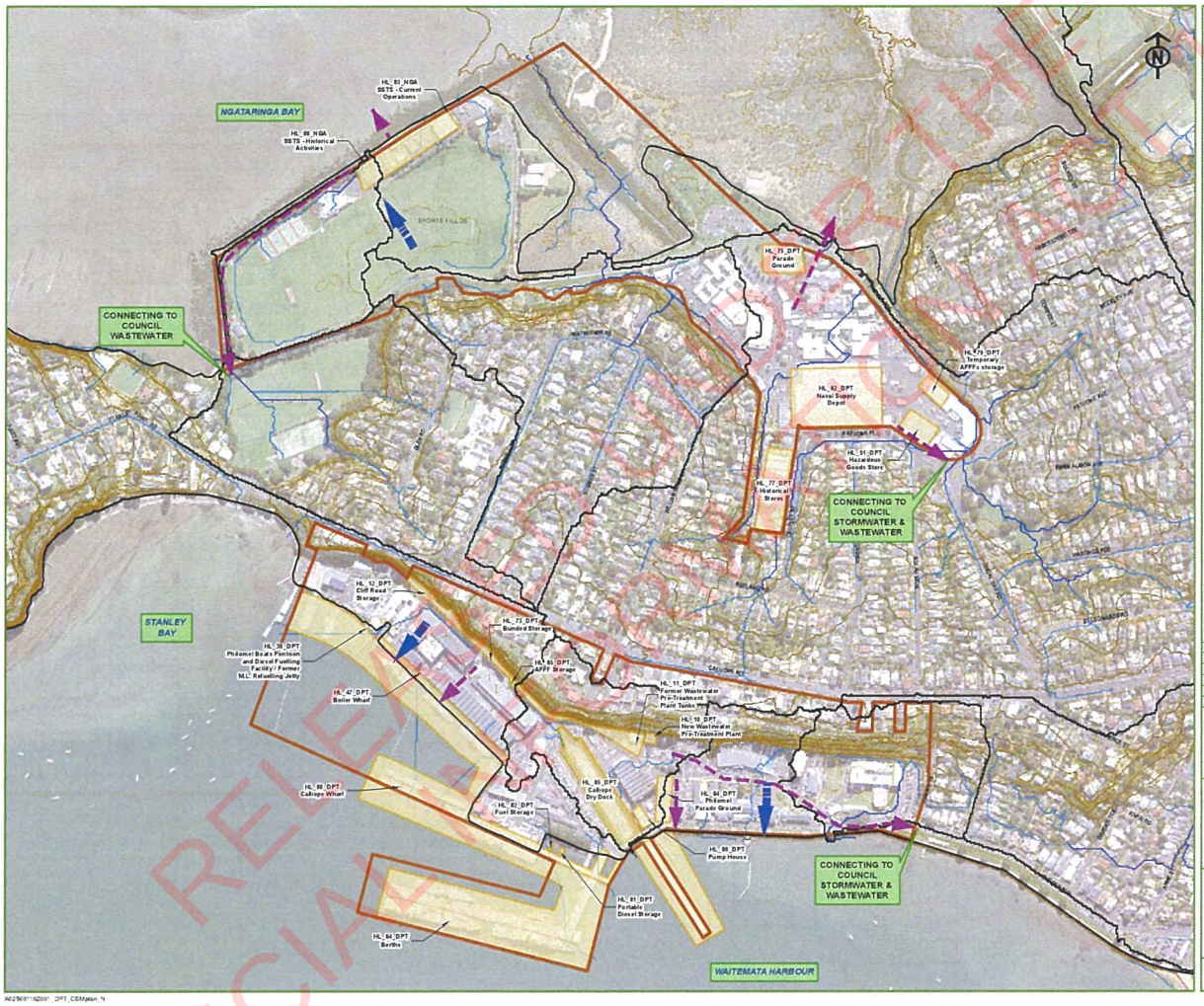
PROJECT NAME:

HMNZS DEVONPORT NAVAL BASE
PFAS PRELIMINARY SITE INVESTIGATION

FIGURE TITLE:

POTENTIAL PFAS SOURCE - HAIL AREAS

SCALE:	FIGURE NO.:	ISSUE NO.:
1:5,000 (A3)	2	B



New Zealand DEFENCE FORCE
Te Ope Kātua O Aotearoa
NAVY NZ ARMY AIR FORCE

KEY:

- Pathway (Groundwater and Surfacewater)
- Source
- Receptor
- Inferred Groundwater Flow Direction

Auckland Council Overland Flow Paths

- 3ha and above
- 4000m2 to 3ha
- 2000m2 to 4000m2
- Auckland Council River and Overland Flow Path Catchment
- Base/Camp Boundary

BOUNDS
Aerial imagery flown 2015-2016 orthomos. overland flow path and catchments supplied by Auckland Council. Vertical datum of orthomos Auckland 1946
Topographic information supplied by LINZ.
Cadastral information supplied by NZDF, dated 19/10/16

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A	ISSUE 1	SEP 17

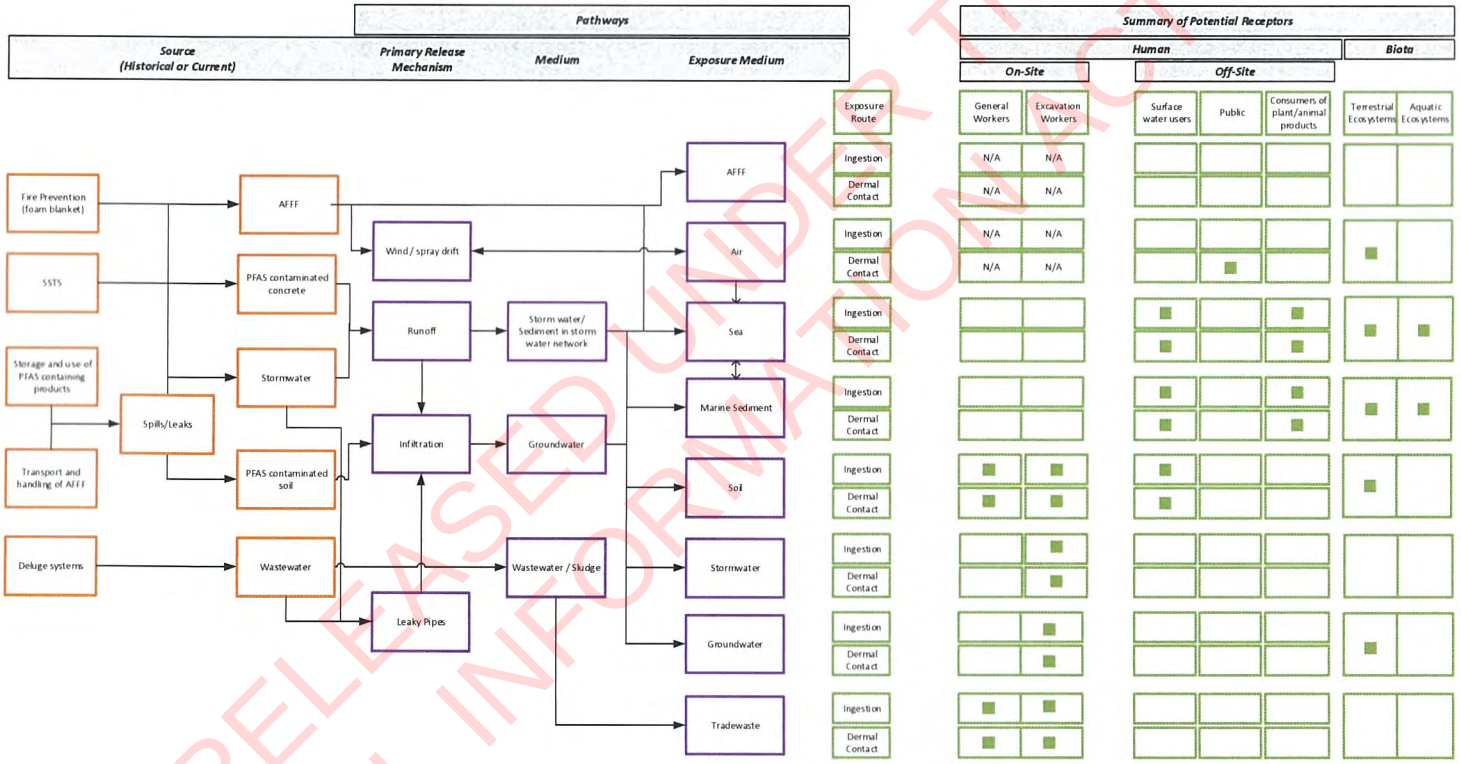
pdp

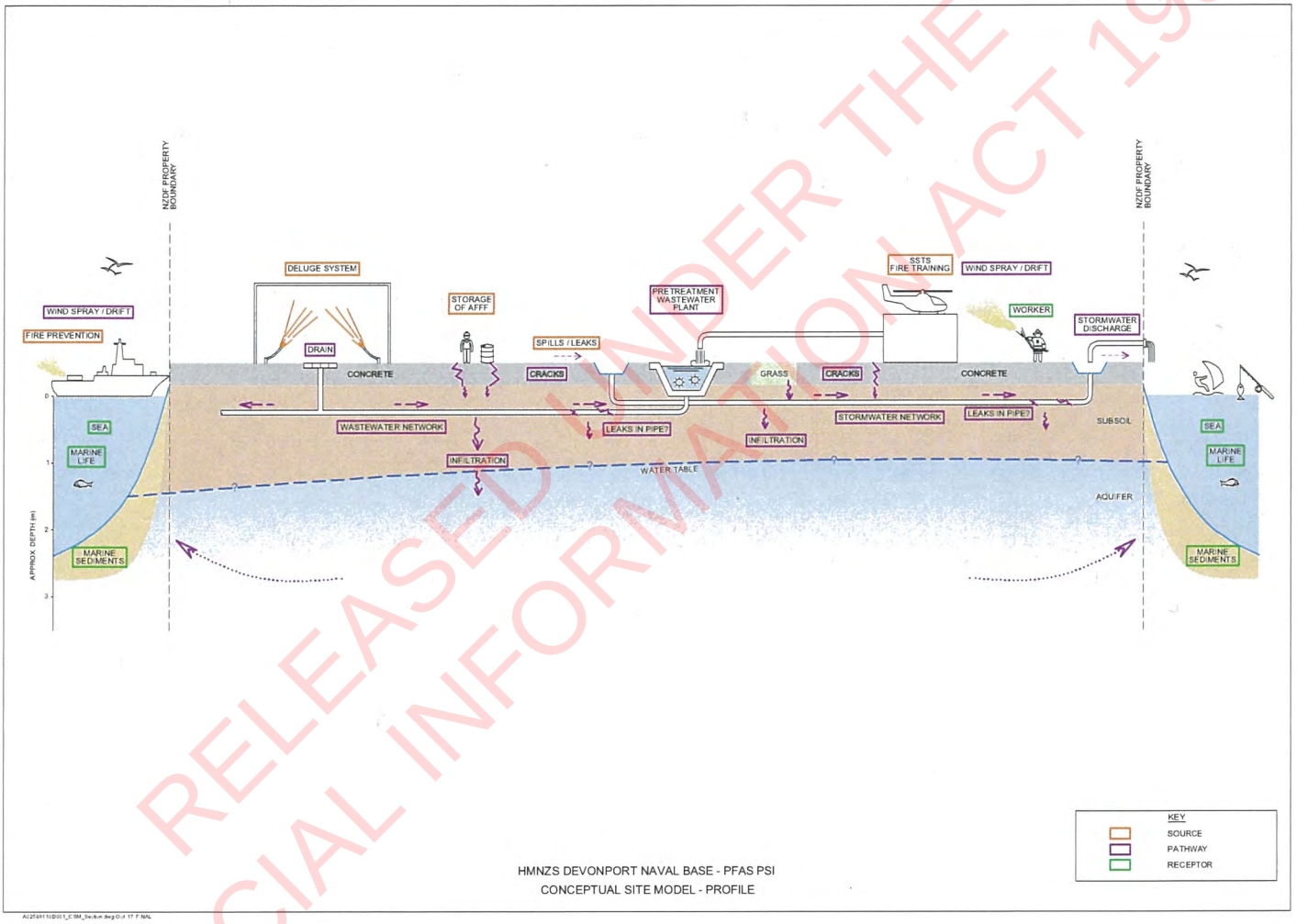
PROJECT NAME:
HMNZS DEVONPORT NAVAL BASE
PFAS PRELIMINARY SITE INVESTIGATION

FIGURE TITLE:
CONCEPTUAL SITE MODEL - PLAN

SCALE:	FIGURE NO.:	ISSUE NO.:
1:5,000 (A3)	3	B

Conceptual Site Model – Devonport Naval Base





HMNZS DEVONPORT NAVAL BASE - PFAS PSI
CONCEPTUAL SITE MODEL - PROFILE

Appendix A

Council Property Files

Appendix A: Council Property Files

Refer separate file – A02569110R001_PFAS_PSI_APPENDIX_A

Appendix B

Tabulated PFAS Results from Previous Investigations

Table B-1: Groundwater Sampling Results - Perfluorinated Compounds (Golder, 2016)

	Perfluorinated Compounds in Groundwater [1]								
Sample Name	MW West	MW East	MW4	MW5	Provisional Drinking Water Guidelines		Non Potable water / contact recreation [4]	Ecological Freshwater Guidelines [5]	
Laboratory Reference	ES1608774-010	ES1608774-011	ES1601475-001	ES1601475-002					
Sample Location	MW1	MW2	MW4	MW5					
Date	18/04/2016	18/04/2016	18/01/2016	18/01/2016	MDH [2] & US EPA [3]	AGDoH[4]		95% ecosystem protection	80% ecosystem protection
Perfluoroalkyl sulfonic acids									
Perfluorobutanesulfonic acid (PFBS)	0.345	0.88	0.306	1.50	7 [2]	-	-	-	-
Total Perfluorohexanesulfonic acid (T-PFHxS)	3.21	5.84	2.63	15.4	-	-	-	-	-
Perfluorooctanesulfonic acid (PFOS)									
Total Perfluorooctanesulfonic acid (T-PFOS)	**37.9**	**53.2**	**24.0**	**39.6**	0.027 [2]	-	-	0.13	31
Summation Guideline Values									
Sum of Total PFOS & PFHxS [6]	**41.11**	**59.04**	**26.63**	**55.00**	-	0.07	0.7	-	-
Sum of Total PFOS & PFOA [6]	**38.02**	**53.5**	**24.5**	**41.0**	0.07 [3]	-	-	-	-
Perfluoroalkyl carboxylic acids									
Perfluorohexanoic acid (PFHxA)	0.538	1.32	1.16	6.6	-	-	-	-	-
Perfluoroheptanoic acid (PFHpA)	0.245	0.324	0.917	3.18	-	-	-	-	-
Perfluorooctanoic acid (PFOA)	**0.118**	**0.346**	**0.474**	**1.38**	0.035 [2]	0.56	5.6	220	1,824
Perfluorononanoic acid (PFNA)	0.014	0.01	0.071	0.127	-	-	-	-	-
Perfluorodecanoic acid (PFDA)	0.0040	0.0030	0.018	0.029	-	-	-	-	-
Perfluoroundecanoic acid (PFUnDA)	<0.005	<0.005	0.006	0.007	-	-	-	-	-
Perfluorododecanoic acid (PFDoDA)	<0.005	<0.005	<0.005	<0.005	-	-	-	-	-
Perfluorotridecanoic acid (PFTrDA)	<0.005	<0.005	<0.005	0.01	-	-	-	-	-
Perfluorotetradecanoic acid (PFTeDA)	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-
Perfluorooctanesulfonamides (FOSAs)									
Perfluorooctanesulfonamide (PFOSA)	0.036	0.157	0.029	0.275	-	-	-	-	-
N-ethylperfluoro-1-octanesulfonamide (NEtFOSA-M)	<0.005	<0.005	<0.005	<0.005	-	-	-	-	-
N-methylperfluoro-1-octanesulfonamide (NMeFOSA-M)	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-
Perfluorooctanesulfonamidoethanols (FOSEs)									
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol (NEtFOSE-M)	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-
2-(N-methylperfluoro-1-octanesulfonamido)-ethanol (NMeFOSE-M)	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-
Telomer Sulfonic acids (FTSs)									
1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2 FTS)	1.39	1.85	4.46	17.3	-	-	-	-	-
1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2 FTS)	0.05	0.06	0.48	2.73	-	-	-	-	-
Perfluorodecane sulfonate (PFDcS)	0.06	0.04	<0.005	0.015	-	-	-	-	-

Notes:

1. Results in ug/L
2. Guideline values for PFBS and PFBA (derived 2011) PFOS, PFOA (derived 2017) have been obtained from Minnesota Department of Health (MDH) (see http://www.health.state.mn.us/divs/eh/risk/guidance/gw/table.html)
3. US EPA PFOA and PFOS Drinking Water Health Advisories (see https://www.epa.gov/sites/production/files/2016-05/documents/2016-12361.pdf)
4. Australian Government Department of Health - Health Based Guidance Values for PFAS accessed 01/06/2017 (https://www.health.gov.au/internet/main/publishing.nsf/Content/2200FE086D480353CA2580C900817CDC/$File/fs-Health-Based-Guidance-Values.pdf)
5. WA Department of Environment Regulation (2017). (https://www.der.wa.gov.au/images/documents/your-environment/contaminated-sites/guidelines/Guideline_on_Assessment_and_Management_of_PFAS_v2.1.pdf)
6. Summations are made by adding compounds together, where one compound is below detection limit it is not included in the summation

<LOR = Result is Less than Limit of Reporting
NR = Result Not Reportable
- Denotes No Guideline Value Available

0.48	Concentration exceeds provisional non potable water guidelines.
0.48	Concentration exceeds provisional drinking water guidelines.
0.48	Concentration exceeds 95% ecological guidelines.

Table B-2: Soil and Sediment Analysis Results - Perfluorinated Compounds (Golder, 2016)

Perfluorinated Compounds in Soil and Sediment[1]													
Sample Name	Mangrove 01-0.1	Mangrove 01-0.3	Mangrove 02-0.1	Mangrove 02-0.3	Mangrove 03-0.1	Mangrove 03-0.3	Mangrove 04-0.1	Mangrove 04-0.3	Mangrove QC1	SB2-0.5	SB5-1.25	WA DER FINAL HEALTH BASED SOIL GUIDANCE VALUES	US EPA PFC SOIL SCREENING LEVELS
Laboratory Reference	ES1608774-001	ES1608774-002	ES1608774-003	ES1608774-004	ES1608774-005	ES1608774-006	ES1608774-007	ES1608774-008	ES1608774-009	-	-		
Sample Location	Mangrove 01	Mangrove 01	Mangrove 02	Mangrove 02	Mangrove 03	Mangrove 03	Mangrove 04	Mangrove 04	Mangrove QC1	SB2	SB5		
Date	18/04/2016	18/04/2016	18/04/2016	18/04/2016	18/04/2016	18/04/2016	18/04/2016	18/04/2016	18/04/2016	28/09/2015	23/09/2015		
Depth	0.1	0.3	0.1	0.3	0.1	0.3	0.1	0.3	-	0.5	1.25		
Perfluoroalkylsulfonic acids													
Perfluorobutanesulfonic acid (PFBS)	<0.2	<0.2	<0.2	<0.2	0.5	<0.2	<0.2	0.3	0.2	0.5	<0.2	-	-
Perfluorohexanesulfonic acid (PFHxS)													
Total Perfluorohexanesulfonic acid (T-PFHxS)	<0.2	<0.2	2	2.1	5.2	1.8	0.4	0.5	2.4	35	1.6	-	-
Perfluorooctanesulfonic acid (PFOS)													
Branched Perfluorooctanesulfonic acid (B-PFOS)	-	-	-	-	-	-	-	-	-	674	17.4	-	-
Linear Perfluorooctanesulfonic acid (L-PFOS)	-	-	-	-	-	-	-	-	-	<0.5	<0.5	-	-
Total Perfluorooctanesulfonic acid (T-PFOS)	1.6	5.7	60	22	109	16.6	<0.5	0.6	75	674	17.4	-	6,000
Sumation Guideline Values													
Sum of Total PFOS & PFHxS[4]	1.6	5.7	62	25	114	18.4	0.4	1.1	77	709	19	100,000	-
Sum of Total PFOS & PFOA[4]	1.6	5.7	60	22	110	16.6	<LOR	0.6	75	676	17.4	-	-
Perfluoroalkylcarboxylic acids													
Perfluorohexanoic acid (PFHxA)	<0.2	<0.2	1.0	1.7	1.0	0.8	<0.2	<0.2	1.6	5	2.2	-	-
Perfluoroheptanoic acid (PFHpA)	<0.2	<0.2	0.6	0.8	0.7	0.4	<0.2	<0.2	0.9	0.4	0.4	-	-
Perfluorooctanoic acid (PFOA)	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	2.0	<0.5	1,000,000	16,000
Perfluorononanoic acid (PFNA)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	-	-
Perfluorodecanoic acid (PFDA)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1.1	<0.2	-	-
Perfluoroundecanoic acid (PFUnDA)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-
Perfluorododecanoic acid (PFDoDA)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-
Perfluorotridecanoic acid (PFTrDA)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-
Perfluorotetradecanoic acid (PFTeDA)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-
Perfluorooctanesulfonamides (FOSAs)													
Perfluorooctanesulfonamide (PFOSA)	<0.2	<0.2	0.9	0.2	2.3	<0.2	<0.2	<0.2	1.0	64	0.7	-	-
N-ethylperfluoro-1-octanesulfonamide (NEtFOSA-M)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-
N-methylperfluoro-1-octanesulfonamide (NMeFOSA-M)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-
Perfluorooctanesulfonamidoethanols (FOSEs)													
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol (NEtFOSE-M)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-
2-(N-methylperfluoro-1-octanesulfonamido)-ethanol (NMeFOSE-M)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-
Telomer Sulfonic acids (FTSs)													
1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2 FTS)	<5.0	<5.0	8.0	8.0	24	7.0	<5.0	<5.0	10	62	5.0	-	-
1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2 FTS)	<1.0	<1.0	2.0	<1.0	4	<1.0	<1.0	<1.0	2.0	148	<1.0	-	-
Perfluorodecane sulfonate (PFDcS)	<0.2	<0.2	0.4	<0.2	5.8	<0.2	<0.2	<0.2	0.3	6.2	0.3	-	-

Notes:
1. Results in ug/kg
2. WA Department of Environment Regulation (2017) human health guidelines industrial/commercial (https://www.der.wa.gov.au/images/documents/your-environment/contaminated-sites/guidelines/Guideline_on_Assessment_and_Management_of_PFAS_v2.1.pdf)
3. Residential Soil Screening Levels for Perfluorooctanoic Acid (PFOA) and Perfluorooctyl Sulfonate (PFOS) sourced from US EPA (2009) (no commercial/industrial levels available) (https://archive.epa.gov/pesticides/region4/water/documents/web/pdf/final_pfc_soil_screening_values11_20_09.pdf)
4. Summations are made by adding compounds together; where one compound is below detection limit it is not included in the summation

<LOR - Result is Less than Limit of Reporting
- Denotes No Guideline Value Available